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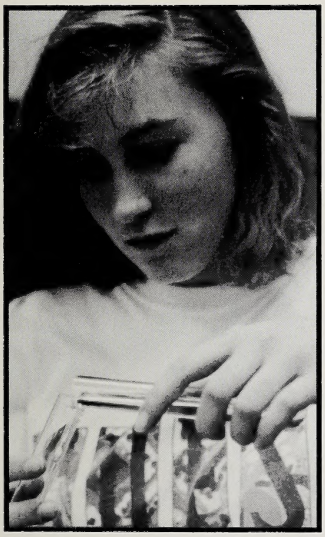

Module 1

Chemical Properties and Changes

Distance Learning

Alberta EDUCATION

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Science 9

Module 1

CHEMICAL PROPERTIES AND CHANGES

Distance Learning

Alberta EDUCATION

Science 9
Student Module
Module 1
Chemical Properties and Changes
Alberta Distance Learning Centre
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Welcome to Module 1!

We hope you'll enjoy your study of Chemical Properties and Changes.

To make your learning a bit easier, a teacher will help guide you through the material.

So whenever you see this icon,

turn on your audiocassette and listen.

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OVERVIEW

You may think that you need to have lots of coloured chemicals to be able to study chemistry. When you mix these chemicals together, you get fizz and smoke – or better yet, an explosion. Of course, it is possible for you to mix chemicals together to get fizz and smoke or to make explosions, but it is also very important that you follow all safety precautions when using chemicals.

9 Science Directions

Look at the photographs on pages xx and 1 of your textbook, *Science Directions 9*. These photographs represent chemistry in real life.

In this module you will learn how chemistry involves the physical and chemical properties of materials and the changes that take place in these materials. Chemistry also involves the study of the nature and speed of the changes that occur. You will learn that common household substances have physical and chemical properties. You will also learn that some household chemicals have hazardous properties when they take part in chemical reactions.

Module 1
Chemical Properties and Changes

- **Section 1** Chemicals and Pure Substances
- **Section 2** Changes and Chemical Reactions
- **Section 3** Acids and Bases
- **Section 4** Controlling Chemical Reactions

Evaluation

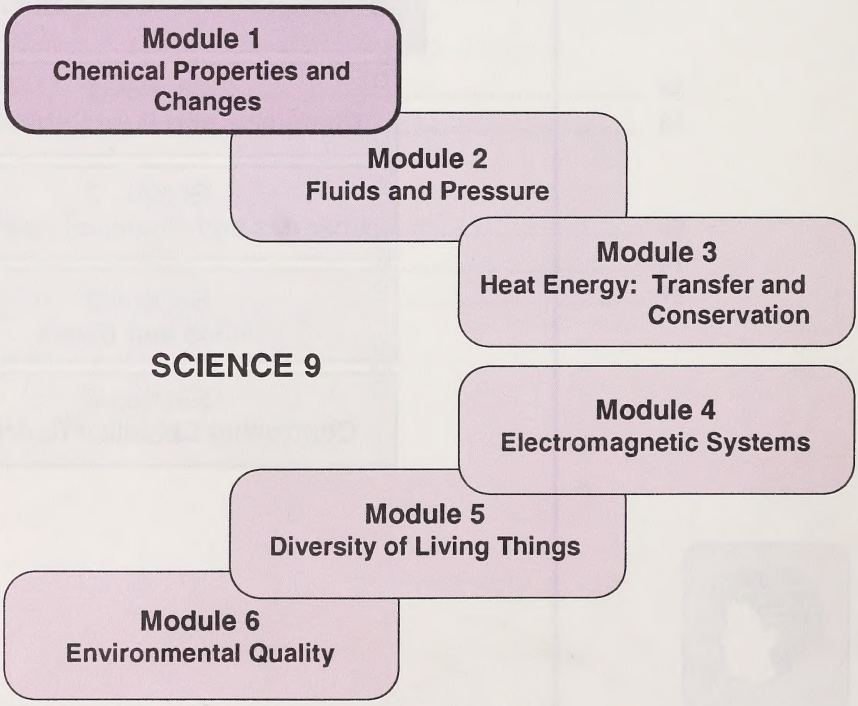
Your mark in this module will be determined by your work in the Assignment Booklet. You must complete all assignments. In this module you are expected to complete four section assignments and a final module assignment.

The assignment breakdown is as follows:

Section 1 Assignment	**20%**
Section 2 Assignment	**20%**
Section 3 Assignment	**25%**
Section 4 Assignment	**15%**
Final Module Assignment	**20%**
TOTAL	**100%**

Course Overview

Science 9 contains six modules. The module you will be working on is highlighted.



Section

1

Chemicals and Pure Substances

These students are looking at the physical properties of some unknown chemicals to help them identify the chemicals. You may have already learned about solutions. The ability of a chemical to form a solution is one of many physical properties that you will be learning about in this section.

In this section you will learn how to collect data to help classify matter. You will also develop an understanding of the relationship between chemicals and matter. You will demonstrate the skills of observation and inference as you gather and interpret data.

Activity 1: Properties of Materials

Close your eyes and imagine what it would be like to discover a new material which would greatly influence the way you live.

1. How would you feel about your discovery?

Share your answer with your learning facilitator.

Imagining feelings is helpful because it increases your desire for more knowledge and discovery.

You may have wondered what a chemical is. Perhaps you already have your own definition and understanding of what a chemical is and what the study of chemistry is all about.

Read pages xx to 3 in your textbook. Then answer the following questions.

2. What is chemistry concerned with?

3. List four things that a chemist does.

4. Which of the properties listed on page 3 of your text may be determined by the sense of sight?

5. Which of the properties listed on page 3 involves the sense of smell?

_____

_____

6. Briefly describe the safe method that you should use to identify odours.

_____

_____

7. Which property listed on page 3 involves a sense that should not be tested in a science laboratory or classroom?

_____

_____

8. Name two properties that can only be determined by making a careful measurement.

_____

_____

Check your answers by turning to the Appendix, Section 1: Activity 1.

Investigation

Refer to Activity 1-1 on page 4 of your textbook.

9. After reading the properties listed in Table 1-2, what do you infer the identity of each of the substances to be?

   a. Substance A _____

   b. Substance B _____

   c. Substance C _____

10. Do question 1 of Analysis.

Check your answers by turning to the Appendix, Section 1: Activity 1.

You have identified three common substances based on some of their familiar physical properties. Now you will see if you can infer the identification of some other unknown substances by observing some of their physical properties.

Investigation

Refer to Activity 1-2 on page 5 of your textbook.

11. Based on the problem statement, what are you really trying to find out in this investigation?

Check your answers by turning to the Appendix, Section 1: Activity 1.

For this investigation you will use samples of Unknowns A, B, C, and D. These samples will be supplied by your learning facilitator. The unknown samples are in sealed containers. You should leave these samples sealed for your safety and so that they can be reused by other students.

Caution: It is important to treat all unknown chemicals as you would treat a dangerous chemical. Handle all chemicals with care! Even common household products can be dangerous if you happen to be allergic to chemicals in them.

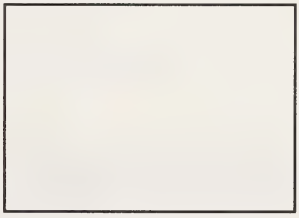
12. What should you do if you spill a chemical?

13. What should you do if your skin comes in contact with one of the chemicals?

Use a hand lens to observe the crystals of each of the unknown chemicals. Make sketches of the crystals in the spaces provided. Then use Table 1-3 and the photographs on page 5 of your text to help you complete the following questions.

14. What is the appearance of Unknown A?

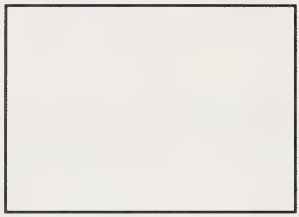
15. Sketch Unknown A.



16. Infer the identity of Unknown A.

17. What is the appearance of Unknown B?

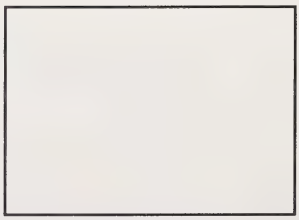
18. Sketch Unknown B.



19. Infer the identity of Unknown B.

20. What is the appearance of Unknown C?

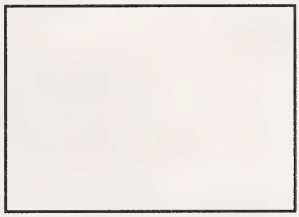
21. Sketch Unknown C.



22. Infer the identity of Unknown C.

23. What is the appearance of Unknown D?

24. Sketch Unknown D.



25. Infer the identity of Unknown D.

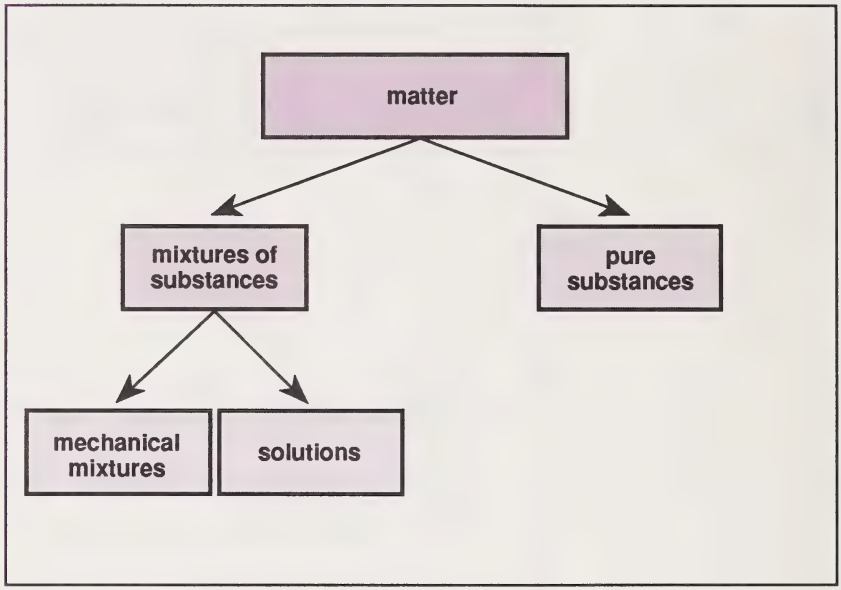
26. Answer question 1 of Analysis.

Check your answers with your learning facilitator.

Mixture: a material that is made up of two or more substances

Pure substance: a substance, such as an element or a compound, that contains only one kind of matter

Matter can be grouped into two large categories. The categories are **mixtures** and **pure substances**. In order to classify matter, you first need to observe the properties of the matter and then decide which category to place it in. Recall that matter may be classified in the following manner.



You will continue to use this system of classification. In fact, in the next activity you will add to this classification system.

If you were looking at a mechanical mixture in one container and a solution or a pure substance in another container, how would they appear different? If you could only see one substance in a container, then it would likely be a pure substance or a solution, but if you could see distinct parts in the container, then it would likely be a mechanical mixture.

Read pages 6 and 7 of your textbook.

You will notice in the observation table on page 7 that each sample has different properties. The right-hand column in this table is where you infer the identity of the unknown substance. In order to classify a substance as pure, some properties that are always the same must be present. For example, it is not possible for you to infer that Sample 2 is tin, based on the observed properities only. Only after you observe that Sample 2 is a shiny, silvery solid and know that it has a density of 7.3 g/cm^3, is it possible for you to infer that it is a pure substance called tin.

In the final investigation of this activity, you will make a series of observations and inferences based on data about chemicals. Observation and inference are important skills for you to demonstrate in this module.

Investigation

Refer to Activity 1-3 on page 8 of your textbook.

27. In addition to inferring the identity of the pure substances, what is the problem in this investigation?

Obtain the ten unknown samples (marked as Unknown E through Unknown N) from your learning facilitator. **Leave these chemicals sealed.**

Caution: It is important to treat all unknown chemicals as you would treat a dangerous chemical. Handle all chemicals with care!

Complete the following chart. For each of the unknown samples, record your observations of its properties in the appropriate columns. Also record the information that is given on the label. From this information you will be able to classify each unknown. In the column labelled *Reasons for Classification*, explain why you classified each unknown as you did. Finally you will infer the identity of the pure substances.

28. Complete the chart.

Sample Number	Observed Properties	Information on Label	Classification	Reasons for Classification	Substance(s)
E					
F					
G					
H					
I					
J					
K					
L					
M					
N					

29. Which of the unknowns are pure substances?

30. Which of the unknowns are mechanical mixtures?

_____

_____

Check your answers with your learning facilitator.

Activity 2: Measuring Physical Properties

Many of the physical properties that you observed in Activity 1 are properties that can easily be measured without sophisticated equipment. In this activity you will be learning techniques that you can use to determine the melting point and the solubility of solids.

Operational definition: a definition based on what can be observed

In the next investigation you will determine the melting point of a substance. How can you find the exact temperature at which a substance melts? If a constant amount of heat is applied to a substance, the melting point of the substance is the temperature midway between the beginning of melting (when the substance is all solid) and the end of melting (when the substance is all liquid). This definition is based on what can be observed and is called an **operational definition**. This operational definition will allow you to find the melting point of a substance.

Before you begin the next investigation, read page 356 of your textbook for a review of graphing.

Investigation

Problem

What is the melting point of *p*-dichlorobenzene?

Caution: Do not use an open flame to heat the test tubes; use a hot-water bath instead. Use oven mitts to handle the apparatus and wear an apron and eye protection.

Materials

- small test tube about half full of *p*-dichlorobenzene
- thermometer
- large test tube in which the small test tube can be placed
- heat source
- 250 ml beaker or metal pot
- a test tube clamp may be used to hold the heated test tubes
- a wire mat may be used if using a glass beaker on the heat source
- another beaker or container for a cold-water bath

Procedure

First read the following quick summary of the procedure.

In the first step of the procedure, you will melt the *p*-dichlorobenzene. This will allow you to place the thermometer directly into the material. Then you will record the temperature as the *p*-dichlorobenzene solidifies. The thermometer will become imbedded into the solid *p*-dichlorobenzene at this point. Finally you will record the temperature as the *p*-dichlorobenzene is remelted.

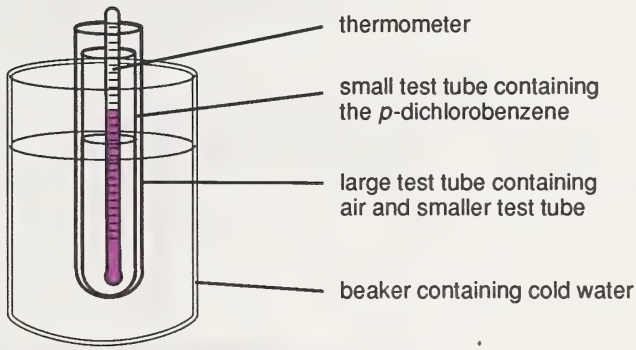
Now you may begin to follow the actual procedure.

- First bring some water to a boil in the hot-water bath. This may be done in a pot on an electric stove. If you are using a beaker, put a wire mat between the beaker and the heat source.

- After the water boils, shut off the heat.

- Place the test tube containing the *p*-dichlorobenzene into the hot-water bath until the *p*-dichlorobenzene has completely melted.

- Set up the cooling apparatus as shown in the next diagram. Place the test tube containing *p*-dichlorobenzene inside a larger test tube for this step.


thermometer
small test tube containing the p-dichlorobenzene
large test tube containing air and smaller test tube
beaker containing cold water

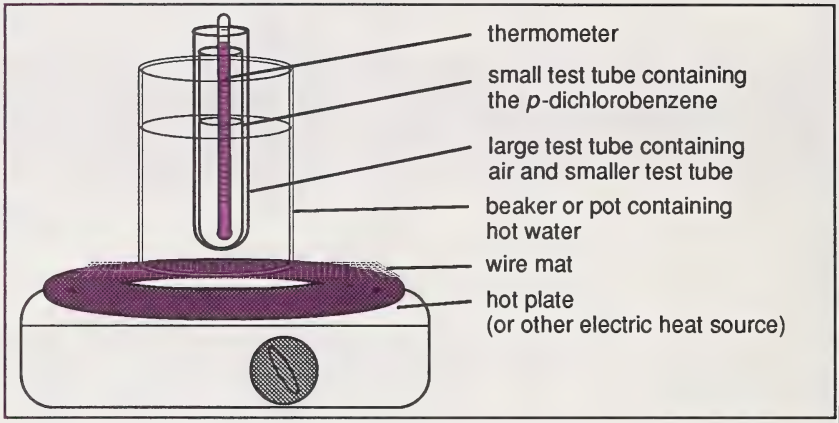
1. Record the temperature at 0.5 min (30 s) intervals until the *p*-dichlorobenzene appears to be solid. (If the experiment takes additional time, space is provided so that you can continue adding to your table.)

Temperature of *p*-dichlorobenzene During Solidification

Time (min)	Temperature (° C)	Time (min)	Temperature (° C)	Time (min)	Temperature (° C)
0.0		4.5		9.0	
0.5		5.0		9.5	
1.0		5.5		10.0	
1.5		6.0			
2.0		6.5			
2.5		7.0			
3.0		7.5			
3.5		8.0			
4.0		8.5			

- Once the *p*-dichlorobenzene has solidified, bring the hot-water bath to a boil again.

- Set up the heating apparatus as shown in the following diagram. Either a beaker with a wire mat or a metal pot may be used. A test tube clamp may be used to hold the test tubes during heating.

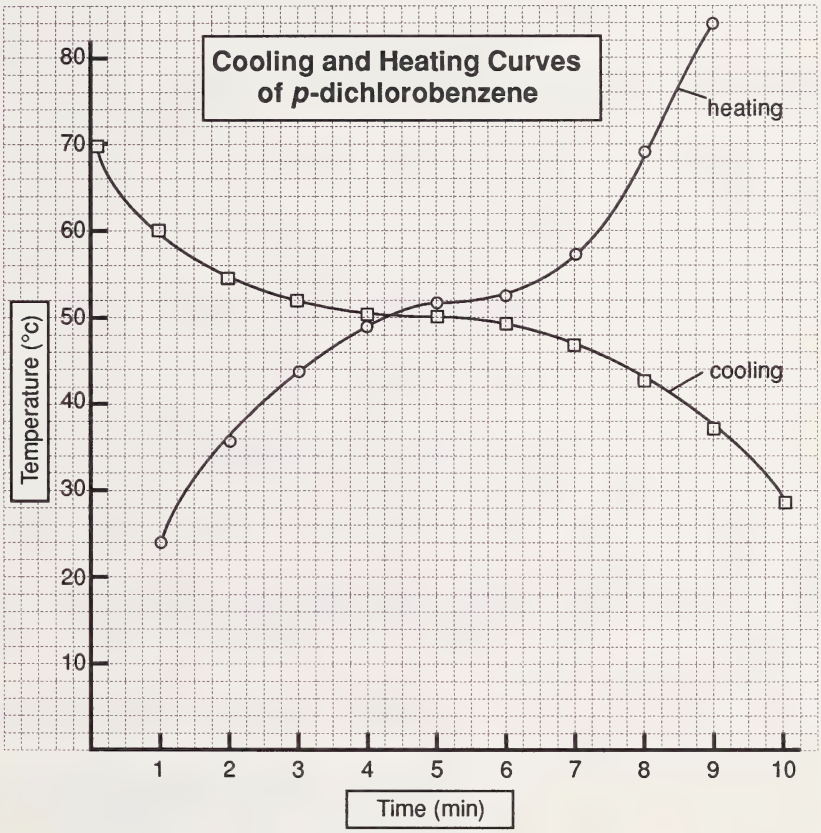

thermometer
small test tube containing the p-dichlorobenzene
large test tube containing air and smaller test tube
beaker or pot containing hot water
wire mat
hot plate (or other electric heat source)

2. Record the temperature at 0.5 min (30 s) intervals until the *p*-dichlorobenzene appears to be completely melted. (If the experiment takes additional time, space is provided so that you can continue adding to your table.)

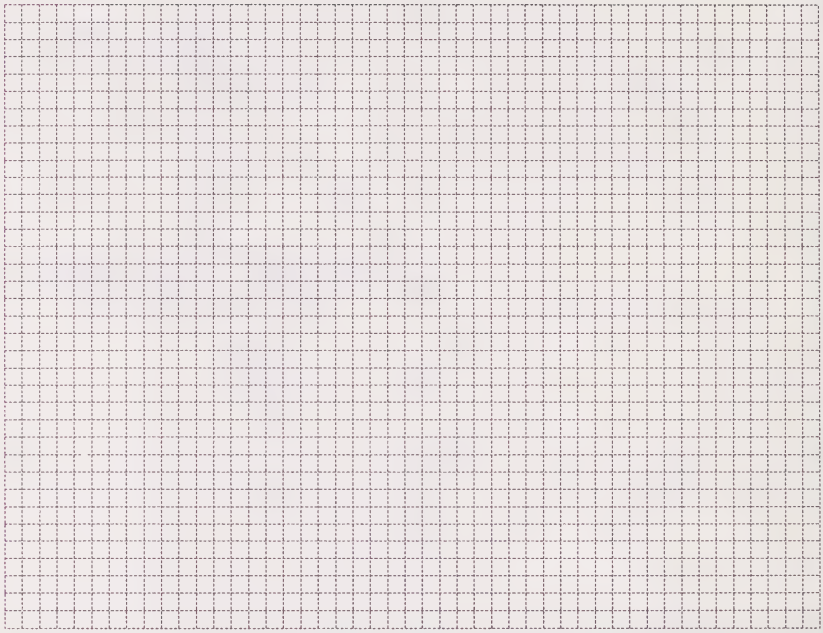
Temperature of *p*-dichlorobenzene During Melting

Time (min)	Temperature (° C)	Time (min)	Temperature (° C)	Time (min)	Temperature (° C)
0.0		4.5		9.0	
0.5		5.0		9.5	
1.0		5.5		10.0	
1.5		6.0			
2.0		6.5			
2.5		7.0			
3.0		7.5			
3.5		8.0			
4.0		8.5			

You will now prepare a graph of your data. Once your graph is complete, it should look similar to the following sample graph.



3. Graph your results on the following grid. Place time on the horizontal axis and temperature on the vertical axis. Place both sets of data on the same graph. Correctly label the curves as *heating* and *cooling*.



- Reheat the test tube of *p*-dichlorobenzene using the hot-water bath.
- Remove the thermometer when the *p*-dichlorobenzene has melted completely. Then hold the thermometer in hot water from a tap until most of the substance is washed off. Finally wipe the thermometer clean with a paper towel or cloth.

See your learning facilitator about what to do with the test tube containing *p*-dichlorobenzene.

From your previous studies you learned that the melting point is the same as the freezing point. In this investigation you collected data on both the freezing and the melting of a substance.

4. How many times does the curve change on the heating graph?

5. How many times does the curve change on the cooling graph?

_____

_____

6. What is happening to the *p*-dichlorobenzene when the lines of the graph are the flattest?

_____

_____

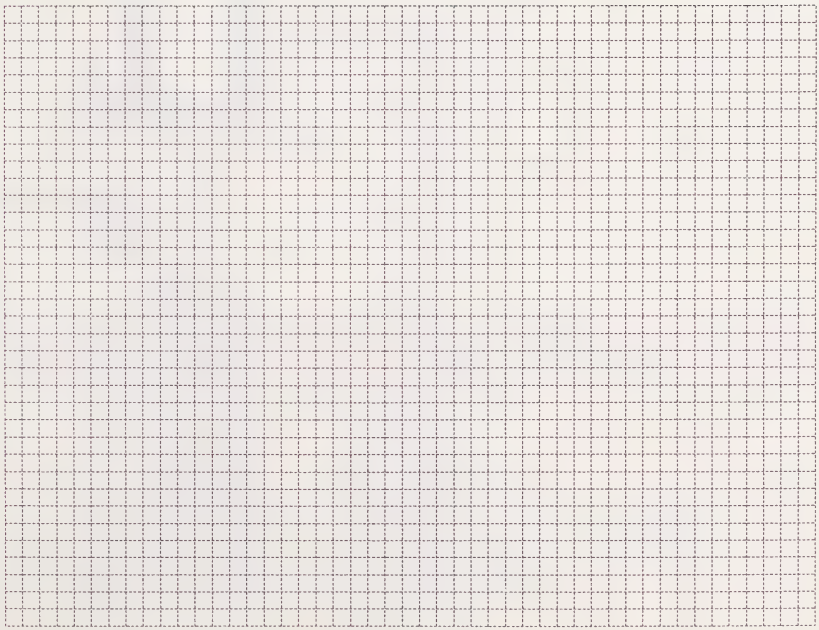
7. What is the melting point of *p*-dichlorobenzene?

_____

8. What is the freezing point of *p*-dichlorobenzene?

_____

9. On the following grid, predict what the graph for the melting of water would look like. Label the axes with the appropriate units.



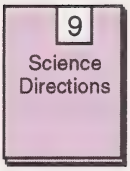
Did you give your graph a title? A graph is not complete until it has a title.

Check your answers with your learning facilitator.

You have learned that density is a property of matter. Although individual objects may vary in size and shape, their ratios of mass to volume will be the same if the type of matter is constant. For example, all iron objects have the same density and all glass objects have the same density. Density is defined as the mass per unit of volume of matter. The formula for density is as follows:

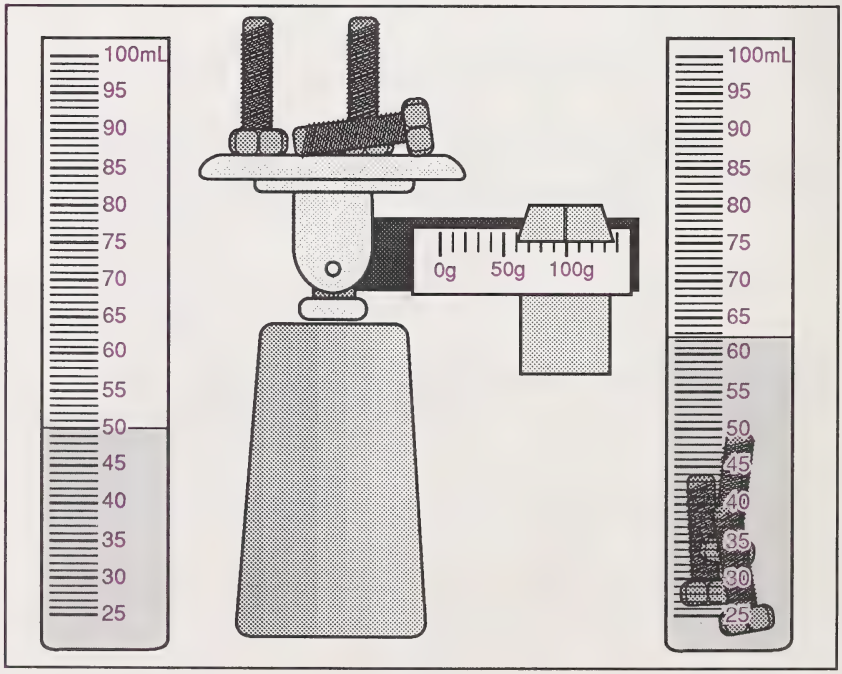
$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

This means that you divide the mass by the volume. Density can be measured in grams per millilitre (g/mL) or grams per cubic centimetre (g/cm^3).



Refer to pages 350 to 352 in your textbook. You will see an example of how density is calculated by displacement.

Use the following diagrams to answer questions 10 through 13.



10. What is the mass of the three bolts?

_____

11. What is the volume of the three bolts?

_____

12. What is the density of the metal?

_____

_____

9 Science Directions

Consult Table 1-4 on page 8 of your textbook.

13. Identify the metal that the bolts are probably made from.

_____

_____

9 Science Directions

14. Do question 2 of Skillbuilding Practice 3-1 on page 352 of your textbook.

_____

_____

_____

_____

_____

_____

Check your answers with your learning facilitator.

Solution: a mixture of two or more substances that appears as if it were only one substance

In the past you learned that mixtures can be separated into mechanical mixtures and **solutions**. You will recall that solutions are made when different types of matter become completely intermingled. Mechanical mixtures result from the different types of matter remaining clumped together.

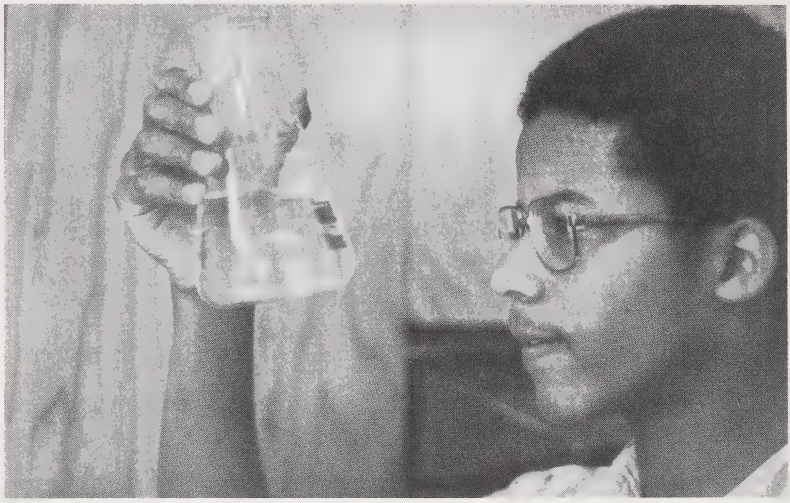
Solubility: the amount of matter which will dissolve in 100 mL of water or other solvent at a certain temperature

Solvent: the substance that is of greater quantity in a solution

Solute: the substance which is being dissolved in a solution

A solution is made up of a solute and a solvent. Water is a very common solvent.

Sometimes only a limited amount of two types of matter will completely mix together at a certain temperature. **Solubility** is one of the physical properties of matter. Solubility is the amount of matter which will dissolve in 100 mL of water or other **solvent**. The matter being dissolved is called the **solute**.



Is the amount of substance that can be dissolved in a liquid unlimited? You will do an investigation to help you answer this question.

Investigation

Problem

How much sodium chloride can you dissolve in water?

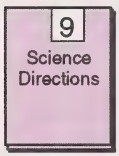
Materials

- 100 mL graduated cylinder
- 125 mL Erlenmeyer flask or 250 mL beaker
- sodium chloride (table salt)
- measuring spoon that holds 5 g of sodium chloride or a balance scale (A teaspoon or 5 mL spoon may also be used.)

If you require a review of measurement skills before doing this investigation, consult pages 348 and 349 in your textbook. For measuring mass, you can use a piece of paper instead of a container. Filter paper is useful for this purpose.

Procedure

- Use the graduated cylinder to measure 25 mL of room-temperature water. Then pour the 25 mL of water into the Erlenmyer flask.



- Gradually add 5 g of sodium chloride to the water. (If you are unable to use a balance scale to measure the mass of sodium chloride, use one level teaspoonful as your measure.) Swirl the flask until all the sodium chloride has dissolved in the water. Repeat this process until no additional sodium chloride will dissolve.

Keep a record of how much sodium chloride you have added to the water. You may have to estimate portions of spoons. It is more accurate if you are able to measure the mass of sodium chloride using a triple-beam balance, postal scale, or similar measuring device. This will allow you to accurately add smaller amounts of sodium chloride and measure the solubility more accurately.

15. Record the mass of sodium chloride which dissolved in 25 mL of water.

_____

Saturated solution: a solution that cannot dissolve any more solute

Once any of the sodium chloride remains undissolved, the solution is said to be a **saturated solution**.

16. Calculate how many grams of sodium chloride will dissolve in 100 mL of water at room temperature (Hint: 100 mL is four times more than 25 mL).

_____

Solubility is given as the number of grams of matter that will dissolve in 100 mL of water at a certain temperature.

17. If you assume that the water you used in this investigation was at room temperature, what is the solubility of sodium chloride at room temperature?

_____

18. If you were given 23.5 g of a substance which has a solubility of 48 g/100 mL at room temperature, could you dissolve all of this substance in 50 mL of water?

_____

You may dispose of your salt solution by pouring it down the drain.

Check your answers with your learning facilitator.

9
Science Directions

Activity 3: Elements, Compounds, and the Atomic Theory

In the previous activities you reviewed the classification system of matter. In this activity you will add to that classification system.

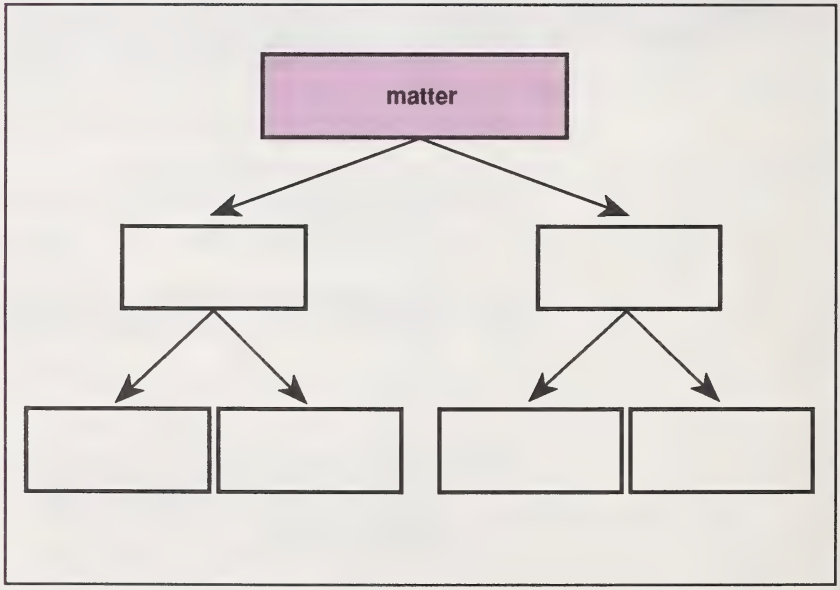
Read pages 9 and 10, and pages 12 to 15 of your textbook. Then answer the next two questions.

1. Which two categories can pure substances be divided into?

_____

_____

2. Complete the classification scheme by filling in the appropriate blanks in the following diagram.



Check your answers by turning to the Appendix, Section 1: Activity 3.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

In this section you learned about the properties of matter and how they relate to your understanding of chemistry. All types of matter have physical and chemical characteristics called properties. Some of the properties of chemicals can be observed so that the chemicals can be classified and identified.

Investigation

Refer to Activity 1-3 on page 8 in your textbook.

You will use three of the unknown samples that you used in Activity 1 of this section. The samples you will be using are Unknowns H, K, and N.

The first step of the classification method involves looking at the unknowns.

1. If a material has separate parts which are visible, how is it classified?

   _____

2. Which of the three unknowns has separate parts which are visible?

   _____

3. How do you classify Unknown N?

   _____

If an unknown cannot be classified simply by looking at it, then it must be either a pure substance or a solution. Both of these types of materials appear to be one substance. Other properties must be used to make the appropriate classification.

4. Which of the unknowns has a property which is listed in Table 1-4 of your textbook?

   _____

5. Is your observation of this unknown the same as the appearance which is listed for the pure substance listed in Table 1-4?

_____

6. How do you classify Unknown K?

_____

7. Which unknown's melting point is not included in Table 1-4?

_____

The materials list in your text tells you that the unknown materials are either pure substances, mechanical mixtures, or solutions made only of the substances found in Table 1-4. This information applies to the Unknowns H, K, and N. This is important information for you. With this information you can infer that an unknown is a solution without making further observations which require testing.

8. What inference can you make about the classification of Unknown H?

_____

_____

_____

Check your answers with your learning facilitator.

9
Science Directions

Enrichment

1. Refer to Activity 1-5 on page 15 of your textbook. Then do textbook questions 1 and 2.

   Textbook question 1:

   Textbook question 2. (a):

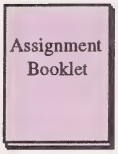
   Textbook question 2. (b):

   Textbook question 2. (c):

Check your answers with your learning facilitator.

Conclusion

In this section you have learned how you can use some of the physical properties of substances to help classify and identify them. You developed an understanding of the relationship between chemicals and matter when you added two new categories, elements and compounds, to your classification system for matter. You have calculated the densities of materials based on mass and displacement. Through your skills of observation and inference, you gathered and interpreted data on melting points and solubilities of some solids.



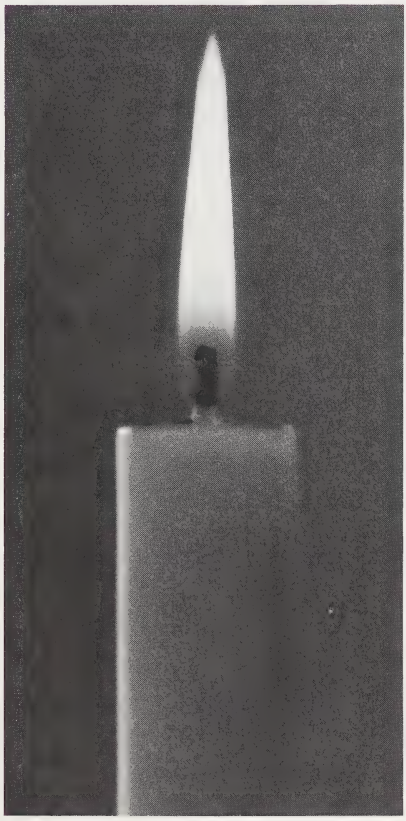
ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 1.

Section

2

Changes and Chemical Reactions



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Some substances seem to do a lot of changing. Changes can be physical or chemical. When a candle burns and the wax disappears, what kind of change takes place? When a kettle boils and all the water disappears, what kind of change takes place? One of these changes is a chemical change, the other is a physical change.

In this section you will learn how to determine the type of change, examine how chemical change can be used as a method of chemical identification, and look at the relationship between energy and chemical change.

Activity 1: Physical and Chemical Changes

In this activity you will learn how to tell the difference between physical and chemical changes.

Read pages 22 and 23 of your textbook. Then answer the following questions.

1. What is formed in any chemical change?

2. In what ways is a physical change different from a chemical change?

3. List five clues that may indicate a chemical change.

4. Why do you need to consider more than one clue before you can indicate that a chemical change has taken place?

Check your answers by turning to the Appendix, Section 2: Activity 1.

Safety is always a concern when chemical changes occur. If heat is given off, you may be burned. If a gas is given off, the substance may explode. When a precipitate is formed, you have to dispose of the new matter in a manner which is safe to the environment. Be sure to follow the directions for the proper disposal of the chemicals that you use in this section.

Investigation

9 Science Directions

Refer to Activity 1-6 on pages 24 and 25 of your textbook.

There are four tasks for each of the four parts of this investigation.

- First you will observe the properties of the substances at the beginning of the investigation.
- Then you will manipulate the chemicals as described in order to bring about the change.
- Once a change has occurred, you will observe the properties of the substances at the end of the process.
- Finally you will classify the change as a chemical change or a physical change.

Part A

Caution: Copper (II) sulphate is poisonous.

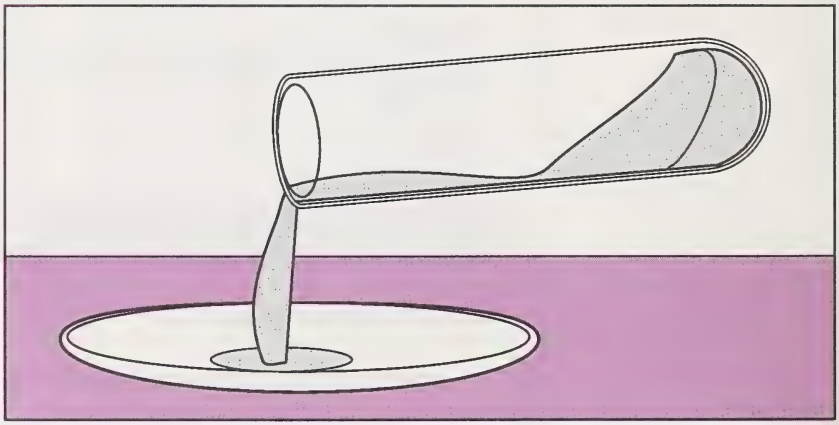
For Part A, follow this procedure.

- Fill the test tube with water to approximately 4 cm depth.
- Obtain about half of a 5 mL spoon or teaspoon (approximately 2 g) of copper (II) sulphate. Observe and record the properties of the copper (II) sulphate.
- Add the copper (II) sulphate to the test tube and stopper the test tube.
- Mix the contents by turning the test tube upside down several times. Be careful of leakage.
- Observe the appearance of the liquid.

5. Use your observations to complete the table.

Names of Starting Substances	Properties	Observations of Change after Mixing

You may wish to put a small portion of the new substance onto a watch glass and allow it to evaporate overnight. This will give you additional data to aid your interpretation. The remaining portion of the new substance will be used in Part B.



6. What was the initial colour of the copper (II) sulphate?

_____

_____

7. What was the final colour after you mixed the two chemicals together?

_____

_____

8. Was there a change which may indicate a chemical change?

_____

_____

9. Was the change chemical or physical?

_____

_____

Part B

You should still have a test tube containing some of the material from Part A.

Caution: Copper (II) sulphate is poisonous.

- Use a stirring rod to push a piece of steel wool into the copper (II) sulphate solution from Part A.
- Wait a minimum of 10 minutes before you write down any final observations about the combined substances.

10. Use your observations to complete the table.

Names of Starting Substances	Properties	Observations of Change after Mixing

11. What was the colour of the steel wool at the beginning of this investigation?

_____

_____

12. What was the colour of the steel wool after 10 minutes?

_____

13. What was the colour of the copper (II) sulphate solution at the beginning of the investigation?

_____

14. What was the colour of the copper (II) sulphate solution at the end of the investigation?

_____

15. Was there a change which may indicate a chemical change?

_____

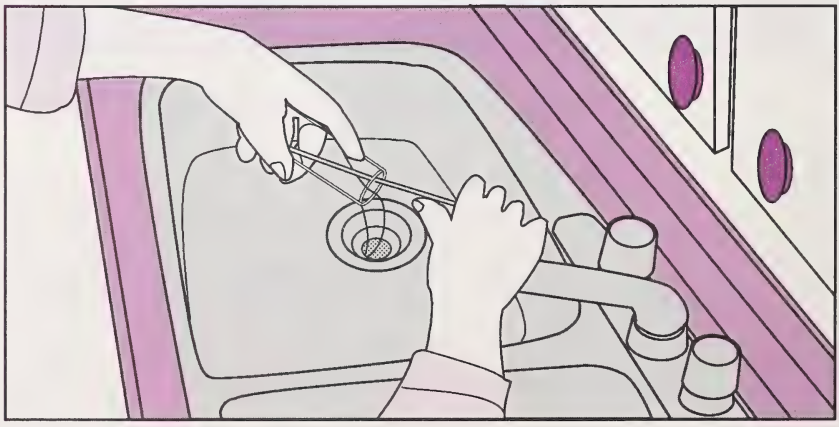
_____

16. Was the change chemical or physical?

_____

_____

Hold back the steel wool with your stirring rod while you pour the liquid part of the test tube contents down the drain. Place the steel wool in the garbage.



Part C

Caution: Acid is corrosive. Any spills on the skin, in the eyes, or on clothing should be washed off immediately with cold water.

9 Science Directions

For Part C, follow the procedure as outlined on page 25 of your text.

17. Use your observations to complete the table.

Names of Starting Substances	Properties	Observations of Change after Mixing

18. Which of your observations may indicate a chemical change?

_____

_____

_____

19. Did a chemical or a physical change take place when you added the magnesium ribbon to the dilute hydrochloric acid?

_____

_____

_____

If all of the magnesium was used in the reaction, pour the test tube contents down the drain. If some solid magnesium remains in your test tube, pour the contents of the test tube into a beaker. Use the stirring rod to pull out the solid magnesium and put it into the garbage. Then pour the liquid down the drain. Flush the drain with water.

9
Science Directions

Part D

For Part D, follow the procedure as outlined on page 25 of the text.

Caution: Compounds which contain lead are poisonous and should be handled with care. Dispose of these chemicals as directed by your learning facilitator.

20. Use your observations to complete the table.

Names of Starting Substances	Properties	Observations of Change after Mixing

21. Both the potassium iodide and the lead (II) nitrate are described as solutions. Which physical properties do they have that allow them to be described as solutions?

_____

_____

_____

22. How would you classify the substance formed after you mixed the two solutions?

_____

_____

_____

23. Was the change a physical change or a chemical change? Explain your answer.

Lead compounds are hazardous. Ask your learning facilitator what to do with the test tube into which you poured the potassium iodide and lead (II) nitrate solutions.

In the previous investigation you learned to recognize and distinguish between chemical and physical changes. Now read about the way that chemists describe chemical reactions on page 27 of your textbook.

9 Science Directions

24. What is another term for chemical change?

25. What is the difference between a reactant and a product?

Check your answers with your learning facilitator.

Activity 2: Reactions and Identification Tests

When you see a friend or a relative, you recognize them by some distinguishing characteristic. This is something you do automatically, without even thinking about it. If you see a purebred dog on the street, you may be able to recognize the breed by its appearance. If it is a breed you have not seen before, you may have to consult a dog book to be sure. You should also be able to identify many household chemicals by their physical properties. Vinegar, which is also called acetic acid, has a very distinctive odour. Salt (sodium chloride) and sugar (sucrose) both have recognizable tastes.

You will recall that behaviour was listed as a property of matter. Behaviour is not a physical property. Behaviour requires a chemical change. When you use a chemical change for identification purposes, you are actually doing a chemical test.

Read more about chemical tests on pages 32 to 35 of your textbook.

1. Tell what tests you would do to distinguish between oxygen and hydrogen.

2. Why could you not use these same tests to determine if a gas is carbon dioxide?

Check your answers by turning to the Appendix, Section 2: Activity 2.

In the next investigation you will look at some common household chemicals which react to produce a gas. You will also design your own procedure for the identification of a chemical and for the safe handling of the materials. Obtain the necessary chemicals from your learning facilitator.

For this investigation you will need to prepare about 250 mL of limewater. To do this, you will need a small jar with a water-tight lid. The jar should have a capacity of at least 300 mL.

Put about 250 mL of water and about 5 mL (1 teaspoon) of calcium hydroxide into the jar. Screw on the lid and shake the jar. Then allow the jar to stand for a few minutes so that the undissolved material settles to the bottom. You will now have a saturated solution of calcium hydroxide (also called limewater). Decant (slowly pour off) the limewater as you need it.

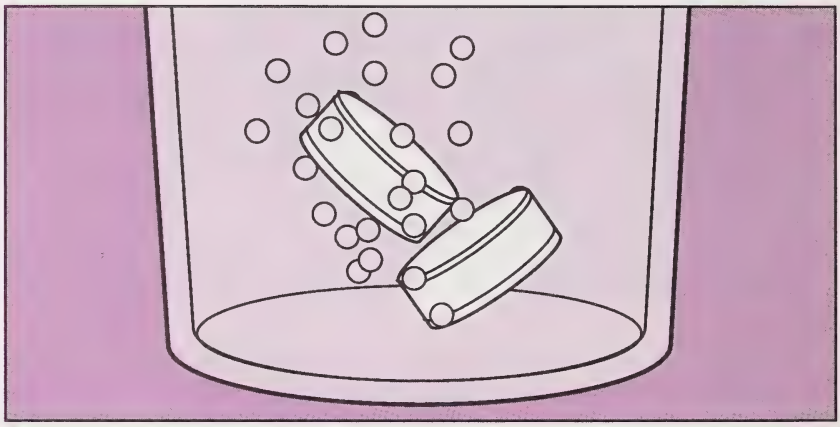
Limewater can go stale quickly. You should use it soon after you have prepared it.

Investigation

Refer to Activity 1-9 on page 34 in your textbook.

9 Science Directions

You will be testing to see if carbon dioxide gas is produced when a seltzer tablet is added to water. You will also test to see if carbon dioxide gas is produced in the reaction of vinegar and baking soda.



3. What is the problem for this experiment?

The following materials are needed for this investigation.

- safety glasses
- limewater
- seltzer tablet
- baking soda
- vinegar
- test tube
- rubber tubing
- rubber stopper with glass tubing inserted
- straw
- beakers or containers as necessary

4. Follow step 1 of the procedure. State your answer and give a reason for your answer to the question in step 1.

5. Write a procedure for step 3 in the textbook.

Share your answers with your learning facilitator.

After you and your learning facilitator have decided that your procedure is safe, proceed to do the experiment.

6. Did the limewater become milky when the gas produced by the seltzer and water was tested for carbon dioxide?

7. Did the limewater become milky when the gas produced by vinegar and baking soda was tested for carbon dioxide?

8. Was the gas produced in either or both of these reactions carbon dioxide?

_____

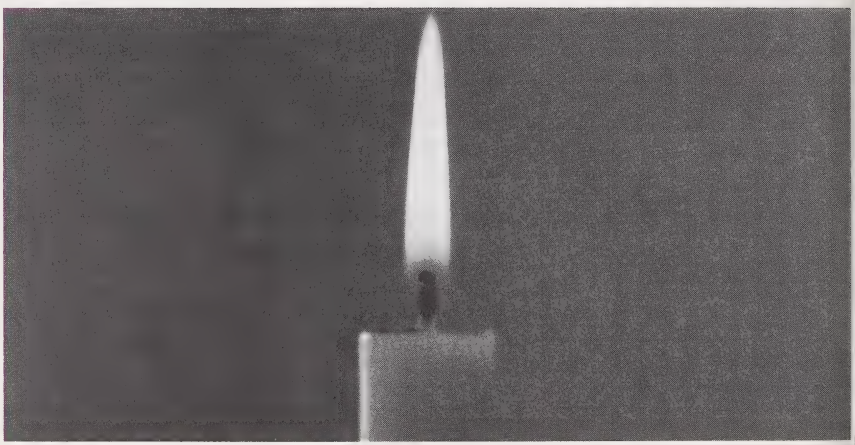
_____

Check your answers with your learning facilitator.

The used or surplus limewater may be safely poured down the sink. If you are doing the next activity within a day, you may save any surplus limewater in the sealed jar for the next activity. You will only need a few drops.

Activity 3: Combustion

Does a burning candle go through a chemical reaction? The next investigation deals with this question.



Prepare some limewater for the investigation. If you have surplus limewater from the previous investigation, you may use it, instead of preparing a fresh stock.

9 Science Directions

Investigation

Refer to Activity 1-10 on page 36 of your textbook.

1. What is the purpose of the limewater in this investigation?

The glass plate in the materials list can be replaced by a small foil pie plate or a piece of foil cut out from such a plate.

2. What is the purpose of the cobalt (II) chloride paper in this investigation?

9 Science Directions

Read Rules for Using an Open Flame on page xiv of your textbook.

3. Why should you never leave an open flame unattended?

Check your answers by turning to the Appendix, Section 2: Activity 3.

9 Science Directions

Follow steps 1 to 6 of the procedure that is outlined on page 36 in the text.

4. Answer question 1 of Analysis.

5. Answer question 2 of Analysis.

   Textbook question 2. (a):

   _____

   _____

   _____

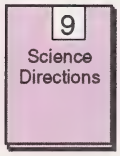
   Textbook question 2. (b):

   _____

   _____

   _____

Check your answers with your learning facilitator.



Activity 4: Energy in Chemical Reactions

Energy is one of those words which seem to have more than one meaning. Think of how many times you speak of or hear about energy in your everyday experiences. In science, energy has a very specific meaning.

Read pages 37 and 38 of your textbook.

1. What is the scientific meaning of energy?

   _____

   _____

   _____

2. Define potential energy.

   _____

   _____

   _____

3. How does chemical energy relate to potential energy?

_____

_____

_____

4. Which word describes a chemical reaction in which energy is released?

_____

5. Which word describes a chemical reaction in which energy must be supplied?

_____

6. Why do some chemical reactions need to have energy added to them?

_____

_____

_____

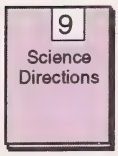
Check your answers by turning to the Appendix, Section 2: Activity 4.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

In this section you learned how to distinguish between chemical and physical changes. When there is a physical change, the type of matter does not change. A chemical change is a change in which new matter is formed. In other words, you have new chemicals in place of the original ones.



1. Refer to page 39 of your textbook. Do Checkpoint questions 1 and 2.

Textbook question 1:

Textbook question 2. (a):

Textbook question 2. (b):

Textbook question 2. (c):

Textbook question 2. (d):

Textbook question 2. (e):

Textbook question 2. (f):

Textbook question 2. (g):

Textbook question 2. (h):

Check your answers with your learning facilitator.

Enrichment

Do Part A or Part B, or both.

Do Part A if you want to do some experimentation.

Part A

Under the supervision of your learning facilitator, do question 8 of Extension on page 26 in your textbook.

1. Which pairs of chemicals underwent a chemical change? Explain your answer.

Share your answer with your learning facilitator.

Part B

2. Refer to page 34 of your textbook. Do question 2 of Further Analysis.

3. Refer to page 36 of your textbook. Do question 5 of Further Analysis.

Check your answers by turning to the Appendix, Section 2: Enrichment.

Conclusion

In this section you looked at some examples of chemical and physical changes. You also learned how to classify changes as chemical or physical changes. You also used the observation of chemical change as a method of chemical identification. Finally, you studied the relationship between energy and chemical change and classified reactions as exothermic or endothermic.

ASSIGNMENT

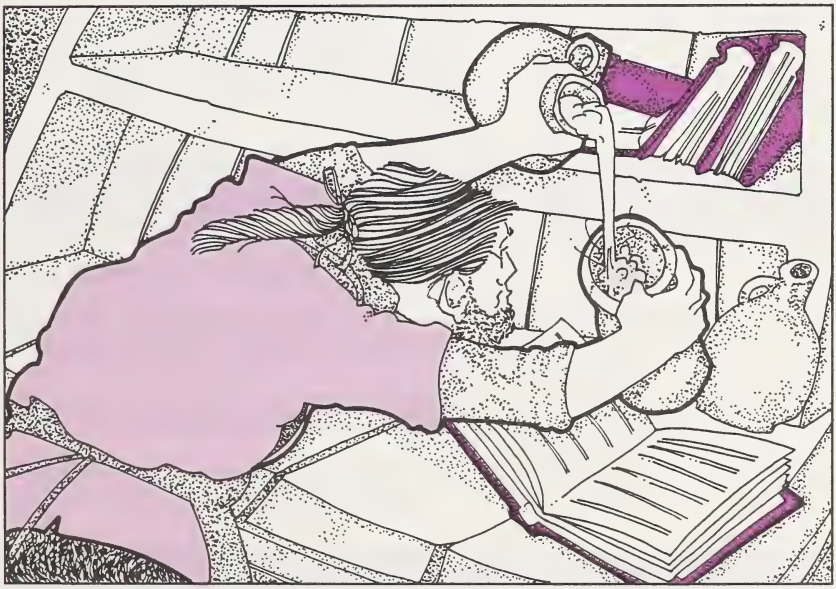
Turn to your Assignment Booklet and do the assignment for Section 2.

Section

3

Acids and Bases

If you were to study the early history of chemistry, you would find that acids and bases were among the first chemicals to be used by humans. However, it is possible that by the end of this section you will know more about the chemistry of acids and bases than any ancient wizard.



In this section you will learn to recognize the hazards of acids and bases. You will also learn the safety procedures that must be followed when using acids and bases. You will be able to describe the effects of acid-base reactions, and describe the effects of acids and bases on other materials as well. You will learn to use various indicators to measure the strengths of acids and bases on the pH scale. You will also learn to identify the presence of acids and bases in household products.

Activity 1: Investigating Acidity in Everyday Substances

Many substances that are found in your home are either acids or bases.

Read page 40 of your text.

1. What is one significant difference between acids and bases that can be determined by taste?

2. If you were given a sauce called "sweet and sour sauce", do you think that this sauce would be an acid or a base?

3. What are substances that are neither acids nor bases called?

4. What do you call a substance that can be used to test for acids and bases?

Governments and industries have worked together to create safer workplaces. You should become familiar with some of the safety symbols that are used on potentially hazardous substances.

Refer to Handling Materials on page xiii in your textbook.

5. Identify the meaning of the acronym WHMIS.

6. What do the following WHMIS symbols mean ?

a.

b.

_____ _____

_____ _____

Check your answers by turning to the Appendix, Section 3: Activity 1.

In the next investigation you will be using indicators to determine which common household chemicals are acids and which are bases.

Investigation

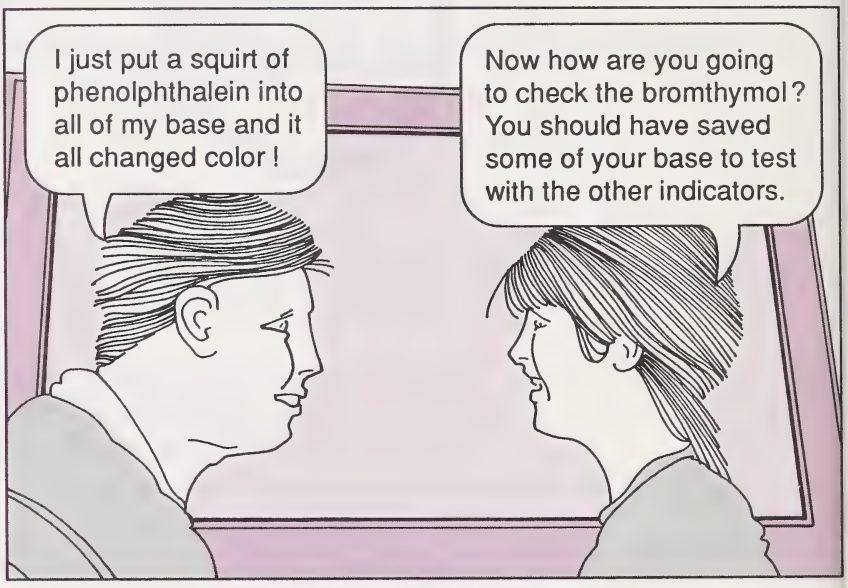
Refer to Activity 1-12 on page 41 of your textbook. See your learning facilitator about obtaining the necessary materials.

Caution: If you spill any hydrochloric acid, sodium hydroxide, or cleaning agents, immediately clean them up with cold water. Never mix household cleaners, as they may react together.

In this investigation you will be using water, an acid (dilute hydrochloric acid), a base (dilute sodium hydroxide solution), and some indicators.

Your first task is to determine what colour each of the indicators turns in water and in the acid and base solutions. Keep a record of the colour changes. When using litmus paper, transfer a drop of the solution to be tested onto the litmus paper with the tip of a glass rod or stirring stick. When using liquid indicators, put one or two drops of the indicator into a small sample of the solution you are testing.

Make sure that you do not use up all of your acid and base supply when testing the first liquid indicator. Always place a small amount (about 2 mL) of your main supply into a fresh container for the testing procedure. Two dropperfuls of acid or base is all you need. Since you have to test the acid and base with four different indicators, make sure you pour out only small amounts each time. You will also need the acid and base for the other activities that follow.


I just put a squirt of phenolphthalein into all of my base and it all changed color !
Now how are you going to check the bromthymol ? You should have saved some of your base to test with the other indicators.

7. What colour did the red litmus turn in water?

_____

8. What colour did the red litmus turn in dilute hydrochloric acid?

_____

9. What colour did the red litmus turn in the dilute sodium hydroxide solution?

_____

10. What colour did the blue litmus turn in water?

_____

11. What colour did the blue litmus turn in dilute hydrochloric acid?

_____

12. What colour did the blue litmus turn in the dilute sodium hydroxide solution?

_____

13. What colour did the phenolphthalein turn in water?

_____

14. What colour did the phenolphthalein turn in dilute hydrochloric acid?

_____

15. What colour did the phenolphthalein turn in the dilute sodium hydroxide solution?

_____

16. What colour did the bromthymol blue turn in water?

_____

17. What colour did the bromthymol blue turn in dilute hydrochloric acid?

_____

18. What colour did the bromthymol blue turn in the dilute sodium hydroxide solution?

_____

Check your answers by turning to the Appendix, Section 3: Activity 1.

Your second task is to find some household chemicals which you can test. Your textbook lists quite a few.

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Caution: Avoid using household ammonia unless your learning facilitator supplies it to you in a diluted form. Make sure that you test only one chemical at a time. Do not mix household chemicals.

Test each of the chemicals with one or two of the indicators. Carefully record your results on a separate sheet of paper.

You may dispose of the used substances normally. They may go in the garbage or down the drain.

19. Which of the materials that you tested were neither acidic nor basic?

_____

_____

_____

20. Complete the following chart.

Foods		Non-foods	
Acidic	**Basic**	**Acidic**	**Basic**

21. Answer question 3 of Analysis.

22. Answer question 4 of Further Analysis.

Textbook question 4. (a):

Textbook question 4. (b):

Check your answers with your learning facilitator.

Activity 2: Measuring Acidity – The pH Scale

While you were testing household chemicals, you probably realized that not all acids and bases are equal in strength. You would not want to stir battery acid in with your food, yet vinegar adds a nice little "bite" to some foods.

Read pages 42 and 43 of your textbook to see how the strengths of acids and bases are measured.

1. What is the scale for measuring acidity?

   _____

2. What is the pH range for acids?

   _____

3. What is the pH range for bases?

   _____

4. Why is universal indicator more useful than litmus paper?

   _____

   _____

   _____

Check your answers by turning to the Appendix, Section 3: Activity 2.

Investigation

Problem

What are the pH values of various materials?

Materials

You will need the same test materials as in the previous activity, but you will use universal indicator paper instead of the indicators that you used before.

Procedure

Retest all of the samples, including the hydrochloric acid and the sodium hydroxide solution, that you tested in the previous investigation. Determine the pH of each sample.

5. Fill in the following chart with your data.

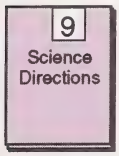
Food	pH	Non-food	pH
		hydrochloric acid solution	
		sodium hydroxide solution	

6. Was the universal indicator any more useful in classifying materials that initially appeared to be neither acidic nor basic? Explain your answer.

The used substances may be disposed of down the drain or in the garbage.

Discuss your answers with your learning facilitator.

Salt: a product formed when an acid and a base are mixed together
Table salt, called sodium chloride, is only one common example. Many other compounds are also called salts.



Activity 3: Mixing Acids and Bases

In terms of the pH range, you probably noticed that acids and bases are at the opposite ends of the scale, with water in the middle. When acids and bases of equal strengths are mixed, water and **salt** are the products of the reaction. You can describe the chemical reaction that takes place with the following general word equation.

$$\text{acid} + \text{base} \rightarrow \text{salt} + \text{water}$$

Read page 44 in your textbook.

1. What is the name given to the reaction of an acid and a base?

_____

When there has been a chemical spill of a strong acid, a weak base is used for the clean-up.

2. Is a chemical reaction being used in the clean-up?

_____

3. What kind of chemical reaction is being used?

_____

4. Why not use a strong base for the clean-up?

_____

_____

_____

If an acid is spilled on your skin, immediately wash it off with a lot of cold water.

5. Is a chemical reaction being used to clean the acid off your skin?

_____

6. Why do you think that this strategy is used?

Check your answers by turning to the Appendix, Section 3: Activity 3.

Investigation

Refer to Activity 1-13 on page 45.

7. Why do you think that the problem for this activity compares the strength of an antacid tablet with baking soda?

Caution: Wash any spills of hydrochloric acid thoroughly with plenty of cold water.

- Collect the materials that you will need. You can use a medicine dropper if the acid is not in a dropper bottle. You will not need a balance; an appropriate spoon may be used.
- Measure 5 mL (about one level teaspoonful) of baking soda into 5 mL of water. Stir the solution until the baking soda has dissolved.
- Add a few drops of indicator solution.
- Do step 2 of the procedure. Use a medicine dropper to add the hydrochloric acid. You may notice a slight colour change around each drop of acid as you add it. You will know that the neutralization reaction is complete when the colour change remains permanent.

8. How many drops of acid are needed to neutralize 5 mL of baking soda solution?

- Do step 4 of the procedure. You will need the approval of your learning facilitator to proceed. You will be adding 5 mL of water to 5 mL of the crushed antacid material and dissolving it to form an antacid solution. Since you use the same volume of baking soda and crushed antacid material, you can assume that you are using an equivalent mass of each.

9. Write out your plan to test the antacid tablet.

Share your answers with your learning facilitator.

Now carry out the plan that you wrote out in question 9.

10. How many drops of acid are needed to neutralize 5 mL of antacid solution?

11. Which required more acid to neutralize it, the baking soda solution or the antacid solution?

12. Answer question 1. (a) of Analysis.

The used substances may be disposed of down the drain or in the garbage.

Check your answers with your learning facilitator.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Remember that behaviour is among the properties or characteristics which help you classify chemicals. Many solutions are either acids or bases. When you try to tell if a substance is an acid or a base, behaviour is one characteristic that you use.

Refer to pages 40, 43, and 44 of your textbook.

1. Complete the following chart.

Property	Acid	Base
Taste		
Touch	not described	
pH Range		
Reaction with Red Litmus	no change stays red	
Reaction with Blue Litmus		no change stays blue
Reaction with Base	neutralization	none
Reaction with Acid	none	

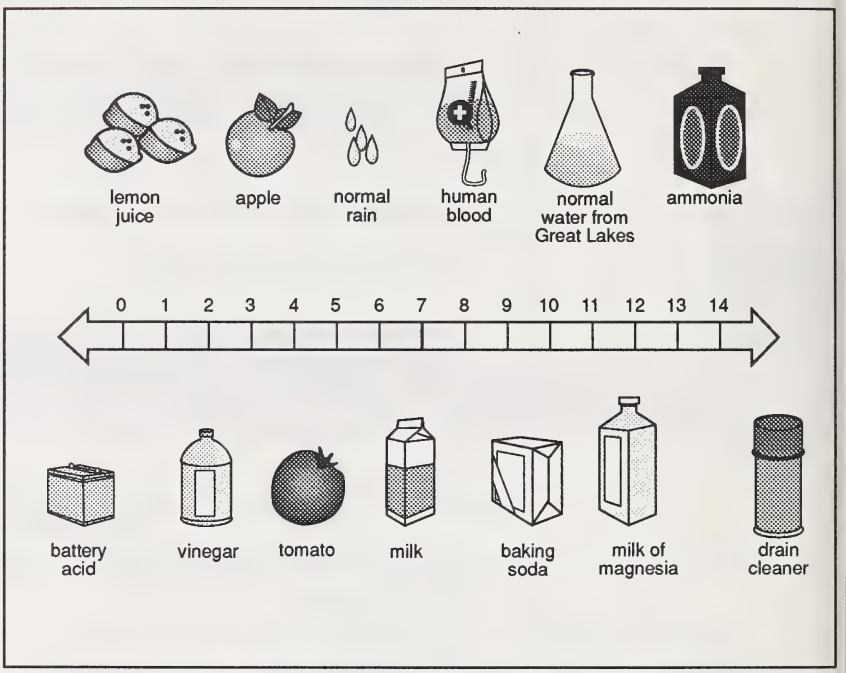
2. Complete the following general word equation.

acid + base → _____ + salt

9
Science
Directions

Refer to page 43 of your textbook.

3. On the bar below, colour the acid end red and the base end blue. Then connect the household products shown to their approximate pH value on the bar. If the product is an acid, use a red line. If the product is a base, use a blue line.



Check your answers by turning to the Appendix, Section 3: Extra Help.

Enrichment

Acids and bases are both solutions which are able to conduct electricity. In acids, the particle which allows the conduction of electricity is a hydrogen ion. When an acid reacts with a metal, the hydrogen ion reacts to form a gas, and the metal reacts with the rest of the acid to produce a salt. Hydrochloric acid produces chloride salts, sulphurous acid produces salts called sulphites, nitric acid produces nitrate salts, and vinegar produces salts called acetates. Similarly named salts are produced by neutralization reactions.

1. What do you think is the name of the gas which is produced in the reaction of a metal and an acid?

   _____

2. Complete the following word equations involving acid and metal reactions.

   a. hydrochloric acid + zinc → _____ + _____

   b. nitric acid + _____ → _____ + zinc nitrate

   c. _____ + aluminum → _____ + aluminum chloride

   d. acetic acid + magnesium → _____ + _____

   e. _____ + _____ → hydrogen + iron acetate

3. Complete the following word equations involving neutralization reactions.

   a. hydrochloric acid + sodium hydroxide → _____ + sodium _____

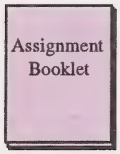
   b. sulphurous acid + calcium _____ → _____ + _____ sulphite

   c. nitric acid + _____ hydroxide → _____ + sodium _____

Check your answers by turning to the Appendix, Section 3: Enrichment.

Conclusion

In this section you learned to recognize the hazards and safety procedures involved in the use of acids and bases. You described the effects of acid-base reactions and the effects of acids and bases on other materials. You learned to use various indicators to measure the strengths of acids and bases on the pH scale. Finally you identified the presence of acids and bases in household products.



ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 3.

Section

4

Controlling Chemical Reactions

All the chemicals necessary for a reaction are found in the head of a match, but the reaction does not take place until the energy of friction is added. Then the reaction takes place rather vigorously. You control the starting time of the reaction with the match, but once underway, the reaction supplies its own energy and continues until the match has burned completely or until you blow it out. With some types of reactions, not only can the starting time be controlled, but the speed of the reaction can be controlled as well. The speed of a reaction is referred to as the reaction rate.

Read about various reaction rates on page 47 of your textbook.

In this section you will predict and describe the effects that changing the concentration of materials, the particle size, and the temperature of the reaction have on the rates of reaction. By examining the reaction rates, you will be able to identify the potential dangers of explosive reactions, and control oxidation and corrosion reactions. You will also apply the scientific inquiry skill of processing data.

9
Science Directions

Activity 1: Factors Affecting Rates of Reactions

WESTFILE INC.

It is important for athletes and their coaches to know what factors or variables affect running speeds. In this activity you will identify variables that may affect the speeds of reactions, or reaction rates. You will develop experimental procedures for the testing and observation of reaction rates.

Manipulated variable: the variable in an experiment that is set and systematically changed by the person doing the experiment

Responding variable: the variable in an experiment which may change because of changes in the manipulated variable

Recall that the **manipulated variable** is the variable that the experimenter changes or manipulates. The **responding variable** is the variable which may change because of changes in the manipulated variable. In general terms, a problem might be stated like this: "How does the manipulated variable affect the responding variable?" For example, in the problem stated "How does the volume of acid affect the volume of base required to neutralize it?", the manipulated variable is the volume of acid. This would be the variable that the experimenter could change. The volume of base required to neutralize the acid would be the responding variable.

Before doing the following investigation, turn to pages 356 and 357 for a review of graphing.

9 Science Directions

Investigation

Refer to Activity 1-14 on page 48 of your textbook.

1. What is the problem?

_____

_____

2. What is the manipulated variable in this investigation?

_____

3. What is the responding variable in this investigation?

_____

Caution: Boiling water can only be placed in heat-resistant glassware. If you are using ordinary glass, use hot (but not boiling) water.

Collect the materials that you will need. If you do the four trials one after the other, instead of at the same time, you will need only one beaker or glass.

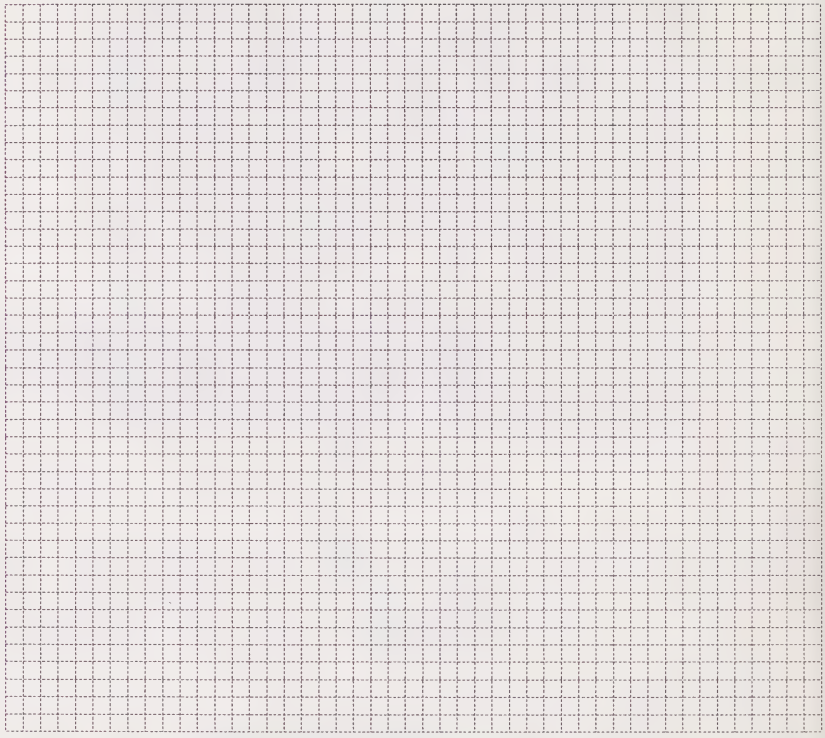
When you prepare a table to help you collect and organize your data, it is convenient to place the manipulated variable on the left-hand side of the table and the responding variable on the right-hand side of the table. The units are usually placed in brackets behind the variables (e.g., Time (min) or Volume (cm^3)).

4. Do step 1 of the procedure.

Do steps 2, 3, and 4 of the procedure. You may do each of the trials separately if you have only one beaker.

5. Record your data in the table you prepared in question 4.

6. Do question 4. (a) of Further Analysis. Use the following grid to plot your graph.



7. Answer question 4. (b) of Further Analysis.

8. Answer question 5 of Further Analysis.

Dispose of the used materials down the drain or in the garbage.

Check your answers with your learning facilitator.

You have learned that reaction rates can be increased at higher temperatures. In the next investigation you will compare the reaction rates as the sizes of the particles change.

Investigation

Refer to Activity 1-15 on page 49 of your textbook.

9. Complete questions 1 to 4 of Predicting.

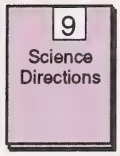
Textbook question 1. (a):

Textbook question 1. (b):

Textbook question 2:

Textbook question 3:

Textbook question 4:

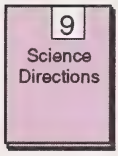


Read about another factor that affects reaction rates on page 50 in your textbook.

10. Define *concentration* in your own words.

11. Make a prediction about how the rate of the reaction may be affected by the concentration.

Investigation



Refer to Activity 1-16 on page 50 of your textbook.

If you are working alone, you are expected to investigate both problems. If you are working with several people, decide which variable your group will investigate and then share your answers with the other groups who investigated the other variable.

Qualitative data: data which is a rough estimate or a description

Quantitative data: data which is obtained with a measurement

Your data will be what is known as **qualitative data**. Qualitative data means that you are giving a description. In this case you will be describing what causes some reactants to increase reation rates. A more sophisticated experiment might collect **quantitative data**. You collected quantitative data in the previous investigation when you actually made measurements and your data was in the form of numbers.

Do either Part A or Part B, or both.

If you wish to investigate the effect of surface area on reaction rate, choose Part A. If you wish to investigate the effect of concentration on reaction rate, choose Part B. Do both parts if you are working alone.

For both parts you will start with one complete piece of white chalk (chemically known as calcium carbonate) and you will cut it in half with a file. You can make the assumption that the two halves are equal in mass.

You may dispose of the used materials down the drain or in the garbage after you have completed the investigation.

Part A

12. State the problem.

_____

_____

13. Predict what you think will be the effect of the particle size on the rate of the reaction.

_____

_____

14. What is the manipulated variable in this investigation?

_____

15. What is the responding variable in this investigation?

_____

You will need the following materials for Part A.

- piece of chalk
- 20 mL of dilute hydrochoric acid
- mortar and pestle or spoon and dish
- two test tubes
- graduated cylinder
- file

Caution: Since bubbles of gas are formed, it is important that you wear safety glasses at all times.

16. Write out your stepwise procedure for investigating the manipulated variable.

17. In the following space, prepare a table in which you will record your data. You will make qualitative descriptions that can include words like *fast*, *slow*, *very fast*, and *very slow*.

Obtain approval for your procedure from your learning facilitator.

Once your procedure has been approved by your learning facilitator, do the experiment and record your data in the table that you prepared.

18. Write a concluding statement which answers the question that was asked in the problem. Comment on the validity (correctness) of your initial prediction.

_____

_____

_____

_____

19. Give an example of a practical application of the knowledge gained from this experiment.

_____

_____

Do questions 28 and 29 that follow Part B.

End of Part A

Part B

You will need to make up a hydrochloric acid solution which you will call "double dilute". To make double dilute hydrochloric acid, you will accurately measure a certain amount (e.g., 5 mL of water) into a test tube and then add an equal amount of dilute hydrochloric acid.

Caution: Always add acid to water. If you add water to acid, then it is possible that you could be splashed and burned by the acid.

20. State the problem.

_____

_____

21. Predict what you think will be the effect of the concentration on the rate of the reaction.

_____

_____

22. What is the manipulated variable in this investigation?

_____

23. What is the responding variable in this investigation?

_____

You will need the following materials for Part B.

- piece of chalk
- about 15 mL of dilute hydrochloric acid
- mortar and pestle or a spoon and small dish
- test tubes
- graduated cylinder
- file

Caution: Since bubbles of gas are formed, it is important that you wear safety glasses at all times.

24. Write out your stepwise procedure for investigating this manipulated variable.

25. In the following space, prepare a table in which you will record your data. You will make qualitative descriptions that can include words like *fast*, *slow*, *very fast*, and *very slow*.

Obtain approval for your procedure from your learning facilitator.

Once your procedure has been approved by your learning facilitator, do the experiment and record your data in the table that you prepared.

26. Write a concluding statement which answers the question that was asked in the problem. Comment on the validity (correctness) of your initial prediction.

_____

_____

_____

_____

27. Give an example of a practical application of the knowledge gained from this experiment.

_____

_____

End of Part B

28. Answer question 3 of Analysis.

29. Answer question 7 of Further Analysis.

Check your answers with your learning facilitator.

Activity 2: Metals and Corrosion

One practical application of chemistry that you may know about is the ongoing battle against the eating away, or **corrosion**, of metals.

Corrosion: the reaction of metals with substances in the environment which leads to the gradual loss of the metal (e.g., rusting of iron)

Read page 51 in your textbook.

1. Take a look around your home or school and find three examples of metal corrosion.

Investigation

Problem

How effective are different methods of rust prevention?

Caution: Do not get chemicals into your eyes. If you do, flush them with water for 15 minutes and see a doctor immediately.

2. What is the manipulated variable in this investigation?

_____

_____

3. What is the responding variable in this investigation?

_____

_____

4. List the rust treatments that you are going to investigate.

_____

_____

_____

5. Predict which treatment you think will provide the best rust protection.

_____

Materials

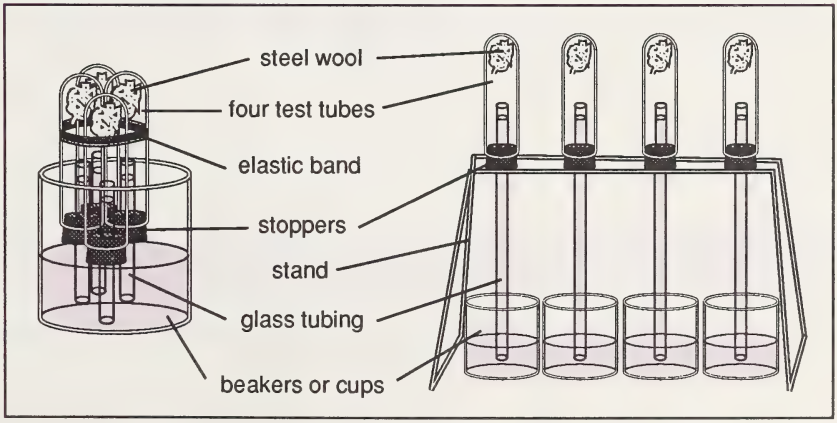
- safety glasses
- steel wool
- four test tubes of the same size
- four one-hole stoppers with glass tubing already inserted
- test tube rack or other support
- water
- food colouring (optional)
- four paper cups or plastic containers, or one large container (e.g., a 250 ml beaker)
- various rust-proofing materials (e.g., oil, wax, paint, etc.)

Procedure

You can investigate the rusting process in a quantitative manner by following this technique.

- First you should protect your work area by covering it with a few sheets of newspaper.
- Choose two or three materials that you are going to coat your steel wool with.
- Dip, spray, or paint each small piece of steel wool with one of the coatings that you chose.
- Allow the coatings on the steel wool to dry if necessary (e.g., paint).
- Dampen each piece of steel wool and insert it into the bottom of a test tube.
- Set up the rest of the equipment as shown by either picture in the following diagram. The test tubes and containers need to be held securely so that they do not tip over.

Caution: Obtain the one-hole stoppers with the glass tubing already inserted. Do not insert glass tubing into one-hole stoppers yourself unless you receive permission from your learning facilitator.



As the steel wool rusts, the oxygen in the test tubes will be used up. This will cause the level of the coloured water to rise in the glass tubes. You will measure the height of the column of water in each tube. You will want to check the level in the tube at intervals, probably twice each day.

6. What type of data are you collecting? Circle the correct word.

   quantitative qualitative

7. In the space provided, prepare a table to collect the data for a 3-day period.

Proceed with the investigation and record your data in the table that you prepared.

Caution: Do not get chemicals into your eyes. You should wear safety glasses when necessary. If you do get chemicals in your eyes, flush them with water for 15 minutes and see a doctor immediately.

8. Write a concluding statement which answers the question that was asked in the problem. Also comment on the validity (correctness) of your initial prediction.

   _____

   _____

   _____

   _____

9. Give an example of a possible practical application of the knowledge gained from this experiment.

   _____

   _____

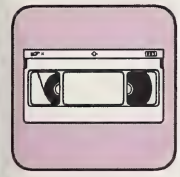
   _____

   _____

10. Refer to the three examples of corrosion which you listed in question 1. Suggest how you would prevent or slow down their corrosion.

Check your answers with your learning facilitator.

Dispose of the used steel wool in the garbage; the rest may be put down the drain.



If possible, watch the video *Chemistry in Everyday Life.* You can get this video from your learning facilitator. In this video you will see some practical applications of chemistry in everyday life.

The following question can be answered even if you were not able to watch the video.

11. Give a practical application of chemistry that is important to you and explain how you personally benefit from this application.

Check your answers with your learning facilitator.

Follow-up Activities

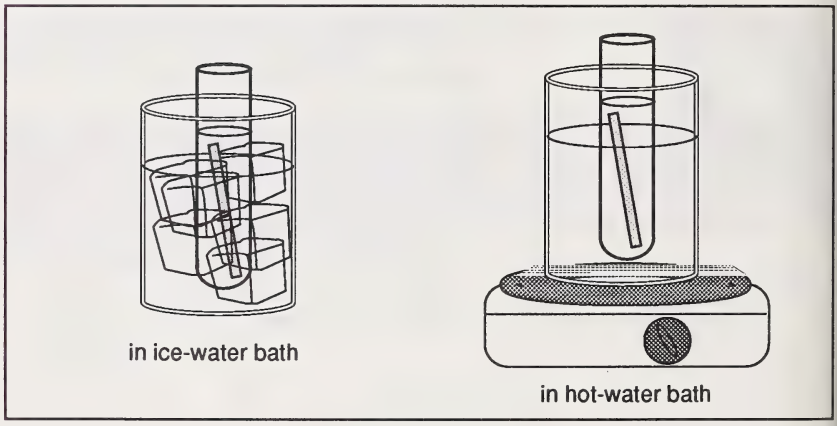
If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

In this section you used science inquiry skills to look at chemical reaction rates. Previously you learned that magnesium and hydrochloric acid will react together to produce hydrogen gas and magnesium chloride. The word equation for this reaction is written as follows.

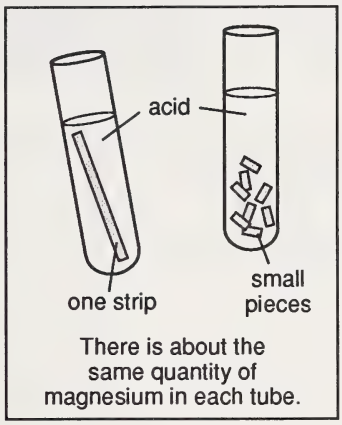
magnesium + hydrochloric acid → hydrogen + magnesium chloride

An experiment involving this reaction could be set up as follows.



A problem for this reaction could be stated as follows: "What is the effect of temperature on the rate of the reaction between magnesium and hydrochloric acid?" In this case the manipulated variable would be the temperature. You, as the experimenter, can change the temperature and look for a change in the rate of the reaction. The responding variable would be the rate of the reaction. The manipulated variable may affect the rate of the reaction.

What would happen if you were to manipulate the size of the magnesium pieces and look at changes in the reaction rate?



1. What would be the manipulated variable in this example?

   _____

2. What would be the responding variable in this example?

   _____

3. Write out a problem statement for where the concentration of the hydrochloric acid is the manipulated variable and the reaction rate is the responding variable.

   _____

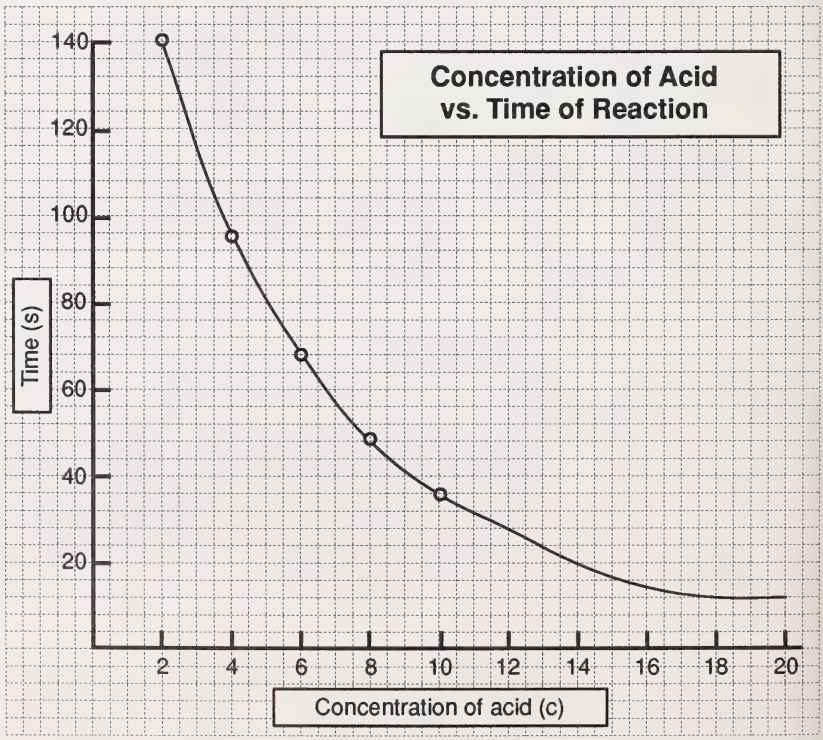
   _____

The following chart shows sample data for the experiment described in question 3. For this sample data, the rate of the reaction is measured by the time it takes to use up all of the magnesium. The concentration of the acid is measured by strength (c). This method shows only how the concentrations compare to each other.

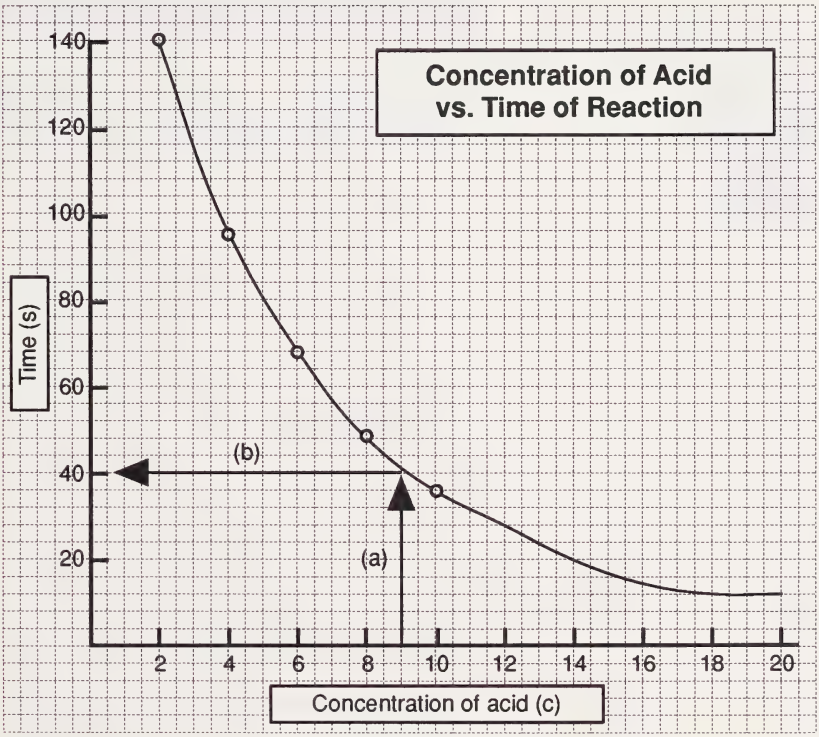
Sample Data

Concentration of Acid (c)	Rate of Reaction as Time (s)
10	36
8	48
6	68
4	96
2	140
1	no reaction seen

The sample data has been graphed on the following grid.



In order to predict how fast the reaction would be with acid strength of 9 c, you would first find 9 c on the horizontal axis (where concentration is plotted). You would then follow arrow (a) upwards until it meets the graph line. From this point on the graph line, you would follow arrow (b) to the vertical axis. The vertical axis shows time. You could now predict that the reaction involving an acid of strength 9 c would take 40 seconds.



4. Use the same graph to predict how much time the reaction would take if the acid strength was 5 c.

_____

When you make predictions that are above the highest experimental value, your prediction is called an **extrapolation**. In the next question you will do some extrapolating.

Extrapolation: a prediction which is above or below the experimental values

5. Use the same graph as before to extrapolate how much time the reaction would take if you had an acid strength of 14 c.

Check your answers by turning to the Appendix, Section 4: Extra Help.

9 Science Directions

6. Refer to page 55 of your textbook. Do Checkpoint question 5. Be sure that your explanations are backed up by the major points that you have learned about reaction rates, temperature, and surface area.

Textbook question 5. (a):

Textbook question 5. (b):

Textbook question 5. (c):

Textbook question 5. (d):

Check your answers with your learning facilitator.

Enrichment

At some point in the future, you may purchase a new car or truck. There are many rust-proofing methods that are available to you. Some of these methods can be done by you. Other methods must be done using commercial treatments.

Investigate rust-proofing treatments for vehicles. You may wish to consult a local librarian to direct you towards the appropriate consumer magazines. You could also interview a local mechanic or the manager of a rust-proofing business.

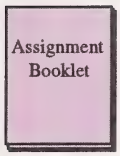
Write a brief report which could be used by consumers who are making a decision about rust proofing a new vehicle.

Share your answers with your learning facilitator.

Conclusion

In this section you learned that rates of reactions are found to vary with the conditions of the reacting materials.

You predicted and described the effects of changing the concentrations of materials on the rates of reaction. You also predicted and described what happens to the reaction when you change the size of the particles, or change the temperature of the reactants. By examining the reaction rates, you were able to identify the potential dangers of explosive reactions. By designing experiments and gathering data, you applied some of the science inquiry skills. Through your knowledge of reaction rates you evaluated different means of preventing oxidation and corrosion reactions.

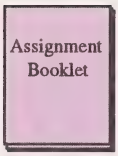


ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 4.

MODULE SUMMARY

In this module you were introduced to the chemical and physical properties of some common substances. Through the scientific inquiry skills, you used investigations to observe and measure the properties of some common substances. You learned that changes in materials may be classified by their physical and chemical properties. You studied some of the chemical and physical properties of common household chemicals, with particular emphasis on acidic and basic chemicals. Through some of the experiments that you developed, you studied the conditions of reactions and their effect on the rates of chemical reactions. Application of this knowledge helped you develop and test methods of preventing oxidation and corrosion of materials.



ASSIGNMENT

Turn to your Assignment Booklet and do the Final Module Assignment.

Appendix

Glossary

Corrosion
- the reaction of metals with substances in the environment which leads to the gradual loss of the metal (e.g., rusting of iron)

Extrapolation
- a prediction which is above or below the experimental values

Manipulated variable
- the variable in an experiment that is set and systematically changed by the person doing the experiment

Mixture
- a material that is made up of two or more substances

Operational definition
- a definition based on what can be observed

Pure substance
- a substance, such as an element or a compound, that contains only one kind of matter

Qualitative data
- data which is a rough estimate or a description

Quantitative data
- data which is obtained with a measurement

Responding variable
- the variable in an experiment which may change because of changes in the manipulated variable

Salt
- a product formed when an acid and a base are mixed together Table salt, called sodium chloride, is only one common example. Many other compounds are also called salts.

Saturated solution
- a solution that cannot dissolve any more solute

Solubility
- the amount of matter which will dissolve in 100 mL of water or other solvent at a certain temperature

Solute
- the substance which is being dissolved in a solution

Solution
- a mixture of two or more substances that appears as if it were only one substance

Solvent
- the substance that is of greater quantity in a solution

Suggested Answers

Section 1: Activity 1

2. Chemistry is concerned with the properties of and changes in matter.

3. Chemists do the following things:

   - observe properties and changes
   - develop models to explain observations
   - use knowledge to control changes
   - produce new kinds of chemicals with practical uses

4. State, colour, texture, lustre, and crystal structure can all be determined by sight.

5. Odour involves the sense of smell.

6. To smell an unknown substance or a chemical, hold the container away from your nose and then, using your hand as a fan, waft the fumes towards your nose.

7. The sense of taste should not be used unless you have been specifically requested to do so. It can be very dangerous.

8. Solubility, freezing and melting point, boiling point, and density are properties which require careful measurement in order to be determined.

9. a. Substance A is water.
   b. Substance B is sugar.
   c. Substance C is diamond.

10. Your answers should be similar to these.

    Substance A is water. The freezing point of 0°C and the lack of solubility in oil were the properties used to identify Substance A.

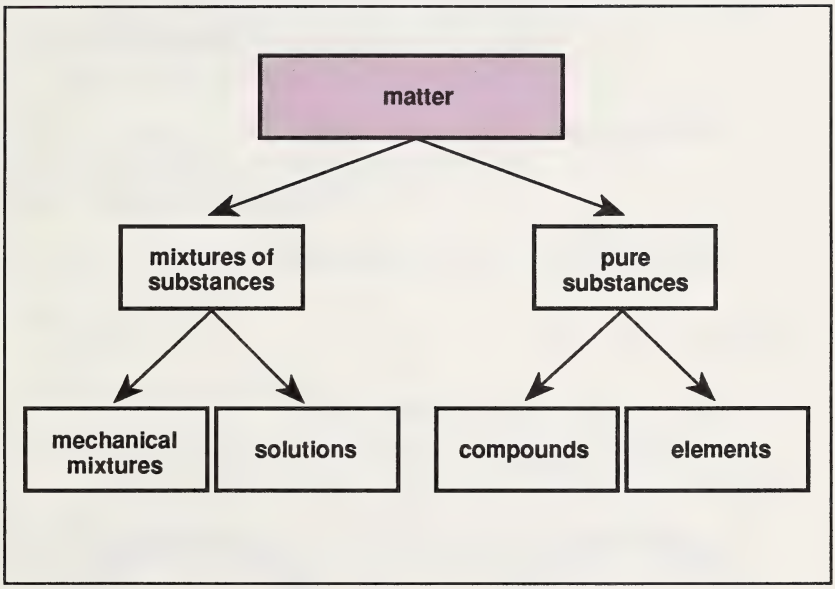
    Substance B is sugar. It was identified by its property of turning black and burning.

    Substance C was identified as diamond. The combination of hardness, crystal structure, and size was used.

11. You are trying to identify unknown substances based on their physical properties.

Section 1: Activity 3

1. Pure substances are either compounds or elements.

2. 

Section 2: Activity 1

1. One or more new substances are formed in any chemical change.

2. No new substance is formed in a physical change.

3. The following clues indicate a chemical change:

   - new colour appears
   - heat or light is given off
   - bubbles of gas are formed
   - solid material (precipitate) forms
   - the change is difficult to reverse

4. One clue by itself is not conclusive. For example, a physical change may also result in a colour change or the formation of gas. You may have given other examples of single clues that are not conclusive enough to tell that a chemical change has taken place.

Section 2: Activity 2

1. You can test for oxygen and hydrogen as follows.

   - Test for oxygen – light a wooden splint
     – blow out the flame to create a glowing splint
     – place the glowing splint into the unknown gas
     – if the splint bursts into flame, the gas is oxygen

   - Test for hydrogen – light a wooden splint
     – hold the burning splint in a small amount of the unknown gas
     – a loud "pop" sound indicates the presence of hydrogen

2. Carbon dioxide does not allow the flame to burn.

Section 2: Activity 3

1. Limewater is used to test for carbon dioxide.

2. The cobalt (II) chloride paper is used to test for water.

3. You should never leave an open flame unattended because something may catch on fire when you are not watching. You may have come up with some other reasons as well.

Section 2: Activity 4

1. Energy is the ability to do work.

2. Potential energy is energy which is stored.

3. Chemical energy is a form of potential energy.

4. **Exothermic** describes an energy-releasing reaction.

5. **Endothermic** describes a reaction that uses energy.

6. The products of the reaction contain more stored (potential) energy than the reactants. The additional energy must be absorbed during the reaction or outside energy is needed to get some reactions started, but once underway, the reactions supply their own energy to continue.

Section 2: Follow-up Activities

Enrichment

2. carbon dioxide + calcium hydroxide → calcium carbonate + water

3. sulphur + oxygen → sulphur dioxide

Section 3: Activity 1

1. Acids taste sour and bases taste bitter.

2. It would be an acid, since acids are sour.

3. They are neutral.

4. An indicator tests for acids and bases.

5. WHMIS stands for Workplace Hazardous Materials Information System.

6.

a.

a. This label indicates corrosive materials.

b.

b. This label is used to indicate materials that cause immediate and serious toxic effects.

7. The red litmus stayed red in water.

8. The red litmus stayed red in dilute hydrochloric acid.

9. The red litmus turned blue in dilute sodium hydroxide solution.

10. The blue litmus stayed blue in water.

11. The blue litmus turned red in dilute hydrochloric acid.
12. The blue litmus stayed blue in the dilute sodium hydroxide solution.
13. The phenolphthalein remained colourless (clear) in water.
14. The phenolphthalein remained colourless in dilute hydrochloric acid.
15. The phenolphthalein turned pink in dilute sodium hydroxide solution.
16. The bromthymol blue remained blue or turned green in water.
17. The bromthymol turned yellow in dilute hydrochloric acid.
18. The bromthymol blue remained blue when placed in the dilute sodium hydroxide solution.

Section 3: Activity 2

1. The pH scale is used to measure acidity.
2. A pH of less than 7 indicates an acid.
3. Bases have a pH of greater than 7.
4. Universal indicator helps you determine the relative strength of different acids and bases. Litmus paper indicates only whether a substance is an acid or base.

Section 3: Activity 3

1. The reaction of an acid and a base is called a neutralization reaction.
2. Yes, the clean-up uses a chemical reaction.
3. A neutralization reaction is used.
4. A strong base is also corrosive and it could also do some damage, instead of helping the situation.
5. Washing with cold water does not involve a chemical reaction. All you are doing is diluting the acid with water.
6. You only use water because you do not want to have damage on your skin from both the acid and the base.

Section 3: Follow-up Activities

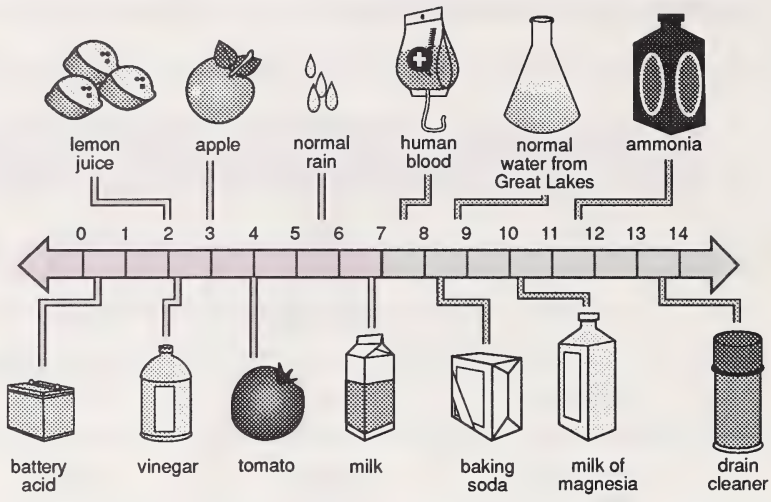
Extra Help

1.

Property	Acid	Base
Taste	**sour**	**bitter**
Touch	not described	**slippery**
pH Range	**0 – 7**	**7 – 14**
Reaction with Red Litmus	no change stays red	**blue**
Reaction with Blue Litmus	**becomes red**	no change stays blue
Reaction with Base	neutralization	none
Reaction with Acid	none	**neutralization**

2. acid + base → **water** + salt

3.



Connecting lines should be red if you connected them to the left side of the bar and should be blue if you connected them to the right side of the bar.

Enrichment

1. Hydrogen is produced.

2. Complete the following word equations involving acid and metal reactions.

   a. hydrochloric acid + zinc → hydrogen + zinc chloride

   b. nitric acid + zinc → hydrogen + zinc nitrate

   c. hydrochloric acid + aluminum → hydrogen + aluminum chloride

   d. acetic acid + magnesium → hydrogen + magnesium acetate

   e. acetic acid + iron → hydrogen + iron acetate

3. Complete the following word equations involving neutralization reactions.

   a. hydrochloric acid + sodium hydroxide → _____water_____ +

   sodium _____chloride_____

   b. sulphurous acid + calcium _____hydroxide_____ → _____water_____ +

   _____calcium_____ sulphite

   c. nitric acid + _____sodium_____ hydroxide → _____water_____ +

   sodium _____nitrate_____

Section 4: Follow-up Activities

Extra Help

1. The size of the magnesium pieces is the manipulated variable.
2. The rate of the reaction is the responding variable.
3. The problem can be written as follows: What is the effect of the concentration of hydrochloric acid on the rate of the reaction?
4. It would take about 80 seconds. This value is read from the graph.
5. The reaction would take 20 seconds.

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